

Red Rot of Sugarcane

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Red rot is a serious disease of sugarcane in the southern United States. It causes a rot of seed cuttings that commonly results in faulty stands of plant cane or sometimes complete failures, reductions in stands of stubble or ratoon crops because of the rotting of the underground parts of the stem from which the crops arise, and annual losses of sucrose in mill cane from infection of the stalks that usually follows injury by the sugarcane moth borer, *Diatraea saccharalis*.

Besides the loss in tonnage from reduced stands of cane, red rot lowers the amount of recoverable sugar at the factory because of the inversion of sucrose in the stalk, which is accompanied by lowered purity of the juice and other untoward chemical changes.

Because it is most destructive as a rot of seed cuttings, red rot causes little injury to seed cane if conditions favor the early germination of the buds after planting, as in the Tropics. In the subtropics, however, such as India, South Africa, and Queensland, where considerable time may elapse between the time of planting and the establishment of new plants, it frequently reduces stands badly. As a rot of mill cane, on the other hand, it may be more important in the tropical areas, where the longer growing season gives the fungus more time in which to spread through the stalks between the time of infection and milling of the cane.

Red rot was first described in Java

in 1893. Shortly thereafter it was identified in the West Indies, where it was considered at first to be a cause of the then prevalent root disease. Within the next 20 years its occurrence was recorded in Queensland, India, Hawaii, and Louisiana. It now is one of the most widely distributed of the diseases of sugarcane.

Red rot has been a major cause of the decline of several varieties of sugarcane in the Southern States. First identified in Louisiana in 1909, it doubtless was a factor in the general downward trend in the average yield that began early in this century in Louisiana. It was one of the causes of the failure of the Louisiana Purple and D-74 varieties in Louisiana in the 1920's and of those and other noble-type varieties in the other Gulf States. It forced the discontinuance as a commercial cane of the variety P. O. J. 2714 in southern Florida.

The noble varieties were replaced in Louisiana with hybrids from Java, one of which, P. O. J. 213, became the leading commercial variety in the State by 1931. Classed as resistant to red rot when it was released, it suddenly failed from red rot in the early 1930's. In the sirup-producing districts of the Gulf States, Cayana 10 and P. O. J. 213 became the most popular replacements of the older canes, but both eventually succumbed to red rot. Some of the other varieties that have succeeded them as important commercial canes have also declined from red rot, but they were tested more rigidly before they were released to growers, and their potential weakness in this respect was recognized at the time of their release.

THE FUNGUS that causes red rot may infect any part of the sugarcane plant. Its principal importance is as a rot of the stalk of standing cane, of seed cuttings, or of the stubble pieces remaining in the ground after the cane is harvested. It produces long lesions on the leaf midribs. The lesions usually cause no serious injury to the plant but are

important in the life history of the disease because they are sources of the spores that cause infection of the stalk.

Red rot often cannot be told on external examination of the stalk unless it has rotted the interior so completely as to cause the rind to lose its natural bright color and to look dull. Plants so affected may be detected by the yellowing, shriveling, and dying of the upper leaves. More certain identification may be made by splitting the stalk or seed cutting. Then one recognizes the disease by the reddening of the normally white or creamy-white internal tissues and cross-barring of the reddened area with occasional white or light patches. Unless the cross bars are present, identification of red rot may be uncertain without microscopic examination or culturing of the fungus. Almost any sort of wounding causes a reddening of the stalk tissues next to the wound, but when red rot is present the characteristic discoloration usually extends considerably beyond the point of origin. In advanced stages of rotting, the interior of the stalk darkens and the tissues shrink, leaving a cavity, which may be filled with the mycelium of the fungus.

The lesions on the leaf midribs are dark or blood red, and may occur as short, discontinuous blotches or as long ones that extend nearly the length of the leaf. The centers become straw-colored with age and are later covered with the black, powdery masses of the spores of the fungus.

The fungus causing red rot is commonly known by its imperfect stage, *Colletotrichum falcatum*, although *Phylospora tucumanensis* is the perfect stage of the fungus. If a fairly large number of isolates of the fungus obtained from different cane varieties or geographic areas are studied on artificial culture media, considerable variation in the type of growth and color of the fungus colony usually is seen. Some isolates or races are light gray and form a loose cottony colony. Others are dark gray and form a restricted velvety colony. Others are intermediate in those re-

spects. If they are inoculated into stalks of sugarcane, the fact that they differ also in pathogenicity—their ability to infect and rot the stalks—will be seen.

It is this variability of the fungus that makes it appear that some sugarcane varieties are unstable in their resistance to the disease. Often a new variety, when it is released to growers, may be resistant to the races of the fungus then prevalent. If a race that is virulent toward that variety is present or appears later, however, it may build up on it and eventually cause serious injury. We have evidence that that occurred with the variety P. O. J. 213 in Louisiana in the early 1930's. Some growers believe this change in predominance of races of disease organisms indicates an inherent change in the sugarcane variety with respect to its disease resistance. The real explanation, though, is to be sought in changes in the prevailing populations of the disease organism.

THE INFECTIONS of the leaf midrib provide the means of dissemination of the disease during the growing season and the source of inoculum for stalk infections. The infections appear in Louisiana in the late spring and continue to develop on new leaves as they are produced during the summer.

On the midrib lesions the fungus produces an abundance of spores, which are carried by wind or splashed by rain to other leaves and plants. Heavy dews and rains wash the spores down the leaf blade to the attachment of sheath to the stalk, where the spore-laden moisture may be held for some time in contact with the nodal region of the stem. The spores may also be washed down the stalk, where they cause infections through the tunnels made by the moth borer.

During the growing season, infection of various parts of the plant may occur at the nodal region, including the buds, leaf scars, and root buds. In very susceptible varieties the fungus may penetrate into the internal stalk tissues of standing cane. As a rule,

however, that does not occur until the stalks are cut and planted as seed cane. Then if temperature and moisture conditions do not favor early germination of the buds and establishment of new plants, the fungus may invade the stalk and impair germination. The extent to which the stalks are invaded through the nodal region varies greatly with different varieties.

In countries where freezing weather does not occur and the cane grows throughout the year, the fungus is always active. Where freezes occur, however, there may be periods of weeks or months when no living portion of the plant is above ground. Then the fungus survives in trash or crop refuse in the planted seed pieces or on stubble from the previous crop. In the spring when growth starts, infection of the new leaves occurs from such overwintering sources. Apparently the fungus does not survive in the soil.

After the fungus invades the tissues of the stalk, the mycelium may spread sidewise and up and down from cell to cell. More rapid longitudinal spread may occur by migration of the spores through the vascular bundles.

Varieties differ in the extent and rapidity of the spread of the spores in this way, because some have many bundles that are continuous through the nodes from one internode to the other. In other varieties few bundles are continuous. In varieties with a large number of continuous bundles, the spores may spread through the entire stalk; if the bundles are discontinuous, the fungus may be checked for a time at the nodes. Thus it happens that some varieties whose tissues have little resistance may not be seriously damaged by the disease because of the checking of longitudinal spread through the nodes. This type of resistance offers less protection, however, if the variety is highly susceptible to infection at the nodes, or if the stalk is seriously damaged by the stalk borer, since the tunnels of this insect in suc-

cessive internodes offer a ready means of separate infection.

Injury to seed cuttings by red rot is not limited to conditions of excessive soil moisture that often prevail in heavy soils, but they do favor greatly the development of the disease. Often the severity of red rot then is also associated with injury by pythium root rot. If the rootlets arising from the seed cutting are destroyed by root rot during germination, the development of the new shoot may be retarded. If red rot has invaded the seed piece, the spread of the disease during the period of delayed establishment of the new plant may kill the young shoots. Thus the degree of injury from red rot may be greatly influenced by the susceptibility of the variety to root rot. A variety that is susceptible to red rot but resistant to root rot may be less injured than one that is only moderately resistant to red rot but very susceptible to root rot.

A common source of infection of the stalk by red rot is through the tunnels of the moth borer. Frequently the degree of injury to mill cane by the disease depends on the extent of infestation by this insect—particularly in areas like Louisiana, where during the relatively short growing season infections of the stalk (other than those that occur from insect injury) do not have time to develop sufficiently to cause important damage to the cane before it is milled. Red rot damage to seed cuttings also is often increased by borer damage and in some varieties may relate directly to the extent of infestation by the moth borer.

Infection of the underground parts of the stem after harvest, from which the stubble or ratoon crops arise, may occur through the tunnels of the sugarcane weevil (*Anacetrinus subnudus*). At times germination of the buds on the stubbles may be impaired by the combined effects of insect and disease injury.

As a seed-rotting disease, red rot is hard to control. Because infection of the stalk to be used for seed has oc-

curred to a great extent before the time of planting, the fungus is largely beyond the reach of fungicides that control many seed-borne diseases of other crops.

Heat treatments that might reduce or eliminate the infection in the stalk are not economically feasible for large-scale use. Furthermore, the fungus is extremely variable; it comprises many parasitic races that apparently are being continually increased by mutation or hybridization. Thus there can be no certainty of the permanence of resistance because of the possibility of the development of virulent, specialized races on initially resistant varieties.

Also, red rot as a seed-rotting disease is favored by the very conditions that retard germination and growth of the cane plant. The balance may be thrown so far in favor of the parasite that ordinarily resistant varieties may at times be seriously damaged by the disease.

Finally, breeding for resistance to red rot is handicapped by the lack in parent material of the high degree of resistance or immunity that is available for some other diseases, such as mosaic or root rot.

Effective control, however, depends on the planting of resistant varieties. Progress has been made in developing resistant varieties under the breeding program of the Department in cooperation with State agricultural experiment stations. The varieties C. P. 36/105, C. P. 44/101, and C. P. 44/155, important commercial varieties in Louisiana, are resistant to red rot, as is C. P. 36/111, recommended for sirup production in Mississippi and other areas of the Gulf States.

Where it is feasible to do so, red rot injury can be avoided to a great extent by planting cane at a time that favors early germination and establishment of the new plants. In Louisiana, for example, part of the acreage commonly is planted in August, when high temperatures usually result in quick germination and establishment of stands. That practice avoids the danger of the

injury that accompanies planting in fall, when there may be little growth for several weeks.

Improvement of drainage and the use of resistant varieties in heavy or inadequately drained soils lessen the hazards of injury. The use of seed cane that is as free as possible of borer infestation is desirable to avoid loss from both insects and red rot.

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For further reading the author suggests his U. S. D. A. Technical Bulletin 641, Red Rot of Sugarcane, published in 1938, and the following:

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